

GROUNDWATER INFORMATION SHEET

N-Nitrosodimethylamine (NDMA)

Revised: August 2010

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information, compiled by the staff of the Groundwater Ambient Monitoring and Assessment (GAMA) Program, is pulled from a variety of sources and relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	N-Nitrosodimethylamine (NDMA)
Synonyms	Dimethylnitrosamine; N-Dimethylnitrosamine; DMNA; N-Methyl-N-nitrosomethanamine; N,N-Dimethylnitrosoamine; N,N-Dimethylnitrous amide; NDMA is one of the group of chemicals known as "Nitrosamines"
Chemical Formula	$(\text{CH}_3)_2\text{N}_2\text{O}$
CAS No.	62-75-9
Storet No.	34438
Summary	NDMA is of interest because of its miscibility with water, carcinogenicity, and toxicity. The California Department of Public Health (CDPH) has established a notification level (NL) for NDMA of 0.01 micrograms per liter ($\mu\text{g/L}$). Used primarily in research, NDMA has also been used in the production of liquid rocket fuel and a variety of other industrial applications. NDMA is an unintended byproduct from disinfection of wastewater and drinking water. NDMA has been reported to be present in foods, beverages, drugs, and tobacco smoke. Based on a CDPH data query dated June 2010 using GeoTracker GAMA, 30 active and standby public drinking water wells of 886 sampled have had concentrations of NDMA above the NL of 0.01 $\mu\text{g/L}$. Most NDMA detections above the NL (26 of 30) have occurred in Los Angeles County.

REGULATORY AND WATER QUALITY LEVELS¹		
NDMA		
Type	Agency	Concentration
Federal MCL	US Environmental Protection Agency (US EPA)	N/A
Federal Maximum Contaminant Level Goal (MCLG)		N/A
State MCL	CDPH	N/A
Detection Limit for Purposes of Reporting (DLR)		N/A
Notification Level (NL) ²		0.01 µg/L
Response Level ²		0.3 µg/L
Public Health Goal (PHG)	OEHHA	0.003 µg/L

¹These levels generally relate to drinking water. Other water quality levels may exist. For further information, see *Water Quality Goals* (Marshack, 2008).

²The Notification Level is a health-based advisory level established by CDPH for chemicals in drinking water that do not yet have MCLs. The Response Level is the concentration at which CDPH recommends removal of a drinking water source from service; NDMA has a Response Level 300 times the Notification Level. For more information on Nitrosamine Notification Levels and Response Levels, see the CDPH website “NDMA and Other Nitrosamines – Drinking Water Issues” at: <http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NDMA.aspx>.

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS^{3,4}	
Detection Type	Number of Groundwater Wells
Number of active and standby public drinking water wells with NDMA concentrations > 0.01 µg/L	30 of approximately 886 sampled.
Top 2 counties with active and standby public drinking water wells with NDMA concentrations > 0.01 µg/L	Los Angeles (26), Sacramento (2)

³Based on CDPH database query dated June 2010 using GeoTracker GAMA.

⁴In general, drinking water from active and standby wells is treated or blended so consumers are not exposed to water exceeding MCLs. Private domestic wells and wells used by small water systems not regulated by CDPH are not included in these figures.

ANALYTICAL INFORMATION		
Method	Detection Limit	Note
EPA Method 521	0.00028 µg/L	Minimum Reporting Level 0.0016 µg/L
Known Limitations to Analytical Methods	US EPA Method 521 should be performed by or under supervision of analysts with experience in solid phase extraction and chemical ionization analysis. Certain aspects of collection, holding, and preservation of samples may influence NDMA analysis. Nitrosamines may be present in trace amounts of rubber products, so these components must be avoided in any sampling, storage, or analytical devices. Samples must be stored in temperature below 10°C during the first 48 hours after sampling, and stored in the lab under 6°C before extraction. Extraction must be done within 14 days of collection.	
Public Drinking Water Testing Requirements	NDMA is on the US EPA list of unregulated contaminants for which monitoring is required. All public water systems serving more than 100,000 people must sample for NDMA. An additional 320 selected systems serving 10,001 to 100,000 people and 480 selected systems serving 10,000 or fewer people must sample for NDMA during a 12-month period during January 2008 through December 2010. CDPH established a Notification Level of 0.01 µg/L in 1998.	

NDMA OCCURRENCE	
Anthropogenic Sources	<p>NDMA's primary use is in research, and is a commonly-used substance to induce cancer in mice for laboratory study. NDMA was also used in the production of 1,1-dimethylhydrazine for liquid rocket fuel. Other industrial uses include as a pesticide (nematicide), a plasticizer for rubber, in polymers and co-polymers, a component of batteries, a solvent, an anti-oxidant, and a lubricant additive. NDMA is not currently manufactured or used (other than for research purposes) in the United States.</p> <p>NDMA has also been detected in treated industrial wastewater, chlorinated drinking and wastewater, treated sewage (in proximity to a 1,1-dimethylhydrazine manufacturing facility), and high-nitrate well water.</p>
Natural Sources	<p>NDMA can form as a byproduct in reactions involving alkylamines. NDMA has been reported as present in tobacco smoke, a variety of foods and beverages, and in prescription drugs. Eating foods with alkylamines can cause NDMA to form in the stomach.</p>
History of Occurrence	<p>In 1998, concern about NDMA contamination at a Sacramento County aerospace facility (Aerojet) prompted investigations in nearby drinking water sources. Samples collected in 1998 from a drinking water well in eastern Sacramento County confirmed the presence of NDMA at approximately 0.15 µg/L. In southern California, NDMA was detected in three drinking water wells in the San Gabriel Basin in 1998. Two wells with NDMA concentrations of 0.07 were removed from service. The third well had previously been removed from service due to additional contamination.</p> <p>In 1999, as interest in NDMA monitoring increased in the water treatment community, CDPH was informed of NDMA detections in treated wastewater. CDPH considered this finding important in the evaluation of proposed recycled water projects involving wastewater discharges and groundwater recharge. In addition, limited sampling indicated that NDMA appeared to be present at very low levels (<0.01 µg/L) in treated drinking water as well. Preliminary analysis suggested that the presence of NDMA in drinking water may be related to the disinfection process.</p> <p>In 2000, a groundwater recharge operation in Orange County involving injection of treated wastewater was found to contain NDMA in the injected treated wastewater; CDPH informed the wastewater treatment plant that its activities were impairing groundwater, and directed them to reduce the levels of NDMA accordingly. <i>(Continued on next page)</i></p>

History of Occurrence (continued)	Additional NDMA detections associated with contamination from chemicals produced in the aerospace industry have occurred in Los Angeles County wells. NDMA detections apparently related to resins used in water treatment for nitrate removal have also been found in Los Angeles County.
Contaminant Transport Characteristics	<p>Laboratory studies are currently being conducted to better understand how NDMA is formed, and how it can be removed from water. NDMA is highly soluble in water. NDMA has a low vapor pressure, and does not readily absorb to airborne particulates. NDMA is rapidly broken down in sunlight. NDMA has a low carbon partition coefficient, which makes it less likely to adsorb to soil and more likely to travel with groundwater flow.</p> <p>Initial research shows NDMA can form through a reaction between monochloramine (a form of chlorine commonly found in water disinfection) and simple amines. Precursors of NDMA in recycled water are being identified, so that additional methods for conventional and advanced treatment can be developed.</p>

REMEDATION & TREATMENT TECHNOLOGIES
<p>UV/Oxidation: Ultraviolet light technology has been used successfully for the destruction of NDMA to levels below drinking water standards. UV can be coupled with the use of hydrogen peroxide in an advanced oxidation system application for NDMA destruction.</p> <p>Biological: A process using bacteria that feed on propane, providing a co-metabolic reaction to break apart the NDMA, is being pilot tested (Bradley and others, 2005; A. MacDonald, Central Valley Regional Water Quality Control Board, personal communication).</p> <p>Granulated activated carbon (GAC) filtration is ineffective as a treatment for NDMA due to the compounds low affinity for carbon.</p> <p>Other Methods: Microfiltration and reverse osmosis treatment may be used to remove NDMA precursors from wastewater prior to chlorination.</p>

HEALTH EFFECT INFORMATION
<p>NDMA causes cancer in laboratory animals such as rats and mice. Chemicals that cause cancer in laboratory animals also may increase the risk of cancer in people. Exposure to high levels of NDMA may cause liver damage in humans; symptoms of overexposure include headache, fever, nausea, jaundice, vomiting, and dizziness. NDMA is not believed to be bioaccumulative.</p> <p>NDMA is identified as a carcinogen under California's Health and Safety Code Section 25249.5, et seq., the Safe Drinking Water and Toxic Enforcement Act of 1986 ("Proposition 65"). In addition, the US EPA identifies NDMA as a "probable human carcinogen" (US EPA, 1997), and the National Toxicology Program lists NDMA as "reasonably anticipated to be a human carcinogen" (NTP, 2000).</p>

KEY REFERENCES

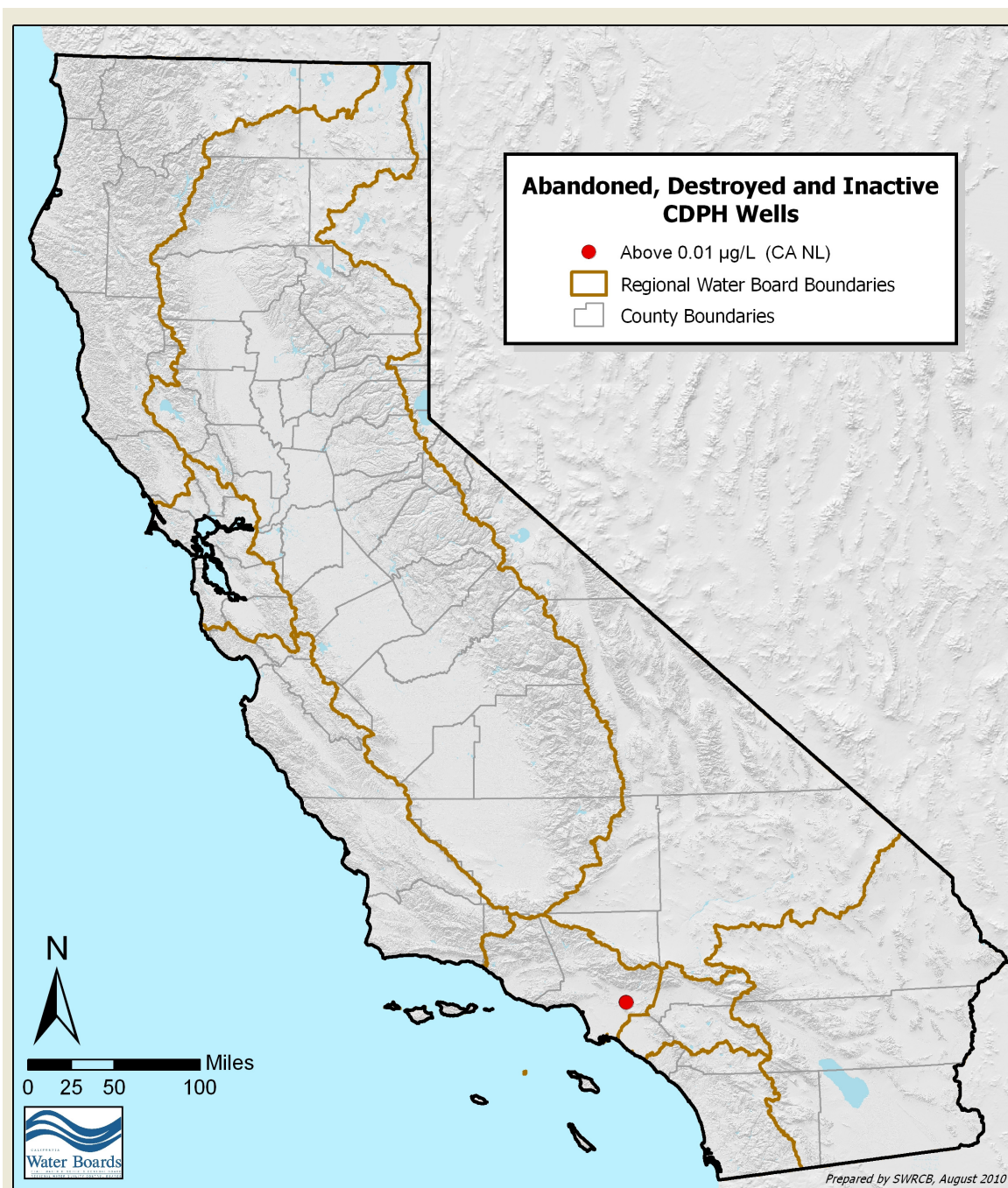
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Active and Standby California Department of Public Health (CDPH) Regulated Public Water Wells with at Least One Detection of NDMA > 0.01 µg/L (NL). (886 wells sampled, 346 wells reported detections, 30 wells above NL).

Source: June 2010 well query of CDPH data using GeoTracker GAMA.



Abandoned, Destroyed and Inactive California Department of Public Health (CDPH) Regulated Public Water Wells with at Least One Detection of NDMA > 0.01 µg/L (NL) (358 wells sampled, 83 wells reported detections, 2 wells above NL).

Source: June 2010 well query of CDPH data using GeoTracker GAMA.